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By: R. Jacobs
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In re application of:)
Eric B. Johansson, et al.) Examiner: to be assigned
Serial No.: 07/914,389) Art Unit: to be assigned
Filed: July 15, 1992) INFORMATION DISCLOSURE
For: OPTIMIZED CRITICAL POWER IN) STATEMENT UNDER
A FUEL BUNDLE WITH PART) 37 CFR §1.97 and §1.98
LENGTH RODS)
)

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

The reference cited on attached form PTO-1449 is being called to the attention of the Examiner. A copy is enclosed.

It is respectfully requested that the cited information be expressly considered during the prosecution of this application, and the reference be made of record therein and appear among the "references cited" on any patent to issue therefrom.

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The Westinghouse Vantage 5 PWR (Pressurized Water Reactor) Nuclear Fuel Assembly discloses a fuel bundle having a bottom nozzle, a top nozzle, Zircaloy grids (or spacers), and three intermediate flow mixers in the upper region of the fuel bundle. The intermediate flow mixers are only used in the upper region (upper one half) of the fuel bundle. In this aspect they have a similarity to Applicants' disclosure -- especially insofar as decreased spacer pitch is utilized in the upper portion of the fuel bundle of Applicants' disclosure.

This prior art resides in a pressurized water reactor. This is a reactor in which the pressure of the water in the vicinity of the fuel rods of the fuel bundle is kept at a sufficient level to prevent appreciable boiling of the water. Applicants' fuel bundle resides in a boiling water reactor. This is a reactor in which the pressure of the water in the vicinity of the fuel rods of the fuel bundle is kept at a sufficiently low pressure to enable appreciable boiling of the water.

This provides a fundamental difference in reactor operation. It produces at least three distinguishing features between the Westinghouse Vantage 5 PWR Nuclear Fuel Assembly and the fuel bundles disclosed in Applicants' disclosure.

First, there is no two phase region within the fuel bundle of a pressurized water reactor. In a pressurized water reactor, sufficient pressure is kept upon the water coolant at all times to prevent boiling.

In such a pressurized water reactor, the phenomenon to be avoided is departure from nucleate boiling (DNB). This phenomenon occurs when the heat generated in the interior of the fuel rods produces steam at the outside surface of the fuel rod cladding at a sufficient rate that a thermally modulating vapor

film is formed on said surface. As a result, a fast destruction of cladding occurs.

In a boiling water reactor, the upper region of the fuel bundle has as a limiting condition known popularly as "dryout" or boiling transition. Specifically, the upper region of the fuel bundle is a two phase region -- typically with the volume of steam present predominating over the volume of water present. During normal operation, the water in this region tends to coat the fuel rods with a relatively thin film. This film is gradually turned into steam -- and is at the same time replenished with water from the surrounding steam-water mixture. If through excessive heating of the fuel rods, the coating of water is turned into steam faster than it is replenished, the fuel rod cladding is subject to the "dryout" condition and thus, exceeds its "critical power limitation."

It is to be noted that this "dryout" phenomenon results in a much smaller reduction in the clad surface heat transfer coefficient than the departure from nucleate boiling (DNB). Typically, with departure from nucleate boiling, destruction of the fuel rod cladding occurs in seconds. With dryout, damage to the cladding requires a significantly larger percentage increase in fuel bundle power level.

Secondly, and with respect to the Westinghouse reference, there is no suggestion or motive to use part length fuel rods in a pressurized water reactor. This can be understood once the reason for the use of part length fuel rods within a boiling water reactor is at least partially set forth.

Part length rods have their primary advantages when both steam and water (i.e., two-phase flow) are present. In the regions of high void fraction (ratio of steam/water volumes) the pressure drop is relatively high. The presence of part length rods significantly increases bundle flow area, which serves to

reduce fluid velocities (relative to the case without part length rods) and therefore, bundle two-phase pressure drop.

The bundle pressure drop is an important parameter relative to the occurrence of both channel (purely hydraulic) instability and core (coupled nuclear-thermal hydraulic) instability, which are also limiting events for boiling water reactor fuel design.

In addition, there are several nuclear advantages from the use of part length rods. Primarily, when part length rods are present, there is more nuclear fuel in the lower, more reactive half of the bundle (due to low average fluid void fraction) than in the upper half of the fuel bundle where the void fraction is higher.

In the case of the Westinghouse fuel bundle within a pressurized water reactor, only single phase flow is contemplated. Part length fuel rods cannot have the same advantages as cited above in the pressurized water reactor environment. To the best of my knowledge, such part length fuel rods have not been used in the pressurized water reactor environment.

Thirdly, and unlike the fuel bundles of boiling nuclear reactors, such pressurized water nuclear reactor fuel bundles are not surrounded by flow confining fuel bundle channels. This means that water can enter into the fuel bundle from the sides of the fuel bundle -- instead of being contained by a fuel bundle channel. As a consequence, flow within the fuel bundle is not solely confined to flow substantially between the bottom and top nozzles. Flow from the side can occur as well, but it is important that this tendency be discouraged by proper design of new fuel bundle concepts, i.e. proper PWR fuel design dictates equal pressure gradients axially between all fuel bundles. This phenomenon is undoubtedly realized by the Zircaloy grid and flow

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mixers in the Westinghouse Vantage 5 Nuclear Fuel Assembly, but could never be achieved if part length rods were present.

For at least the above reasons, it is submitted that although this reference discloses apparent increased spacer density in the upper region of a pressurized water reactor fuel bundle, combination of this reference with boiling water reactor prior art is not suggested.

If the mailing date of this paper is greater than three months after the filing date of this application, and after the mailing date of the first Office Action, the Commissioner is hereby authorized to charge \$200.00 to Deposit Account No. 20-1430. Please charge any additional fees or credit any overpayment to the above-noted deposit account.

Respectfully submitted,

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